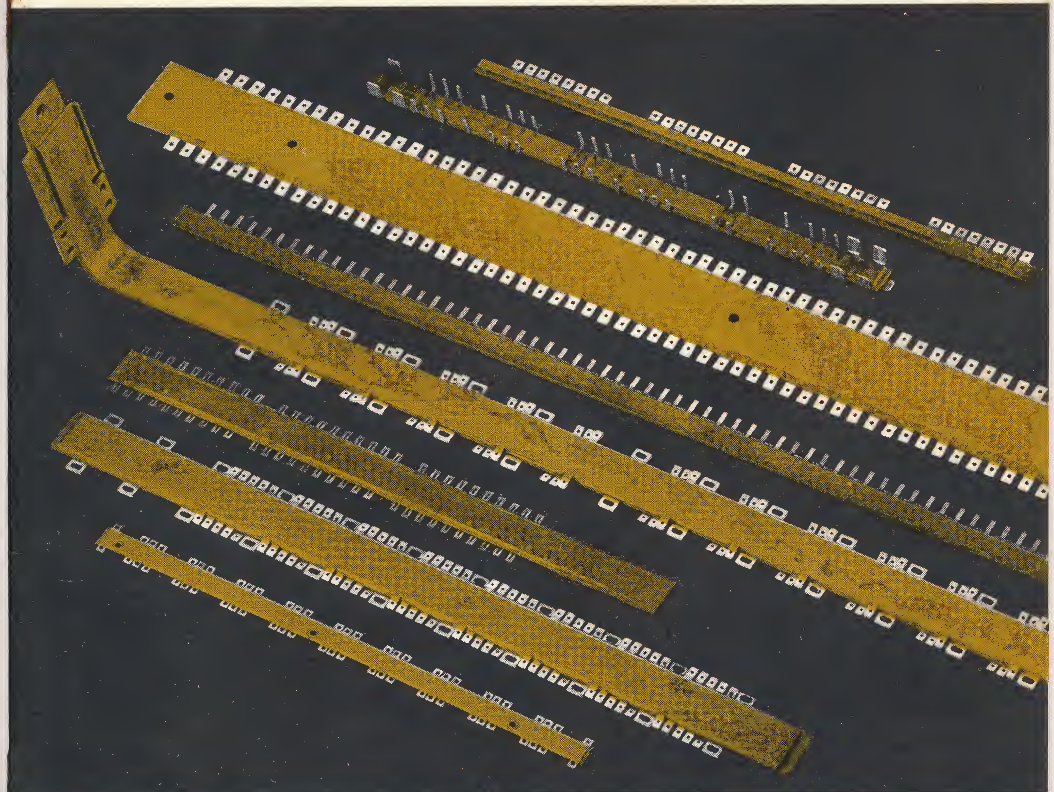
TECHNICAL BULLETIN B-1

LAMINATED and MOLDED BUS BARS

for POWER DISTRIBUTION



ELDRE COMPONENTS, INC.

SYMBOL OF PERFECTION

INTRODUCTION

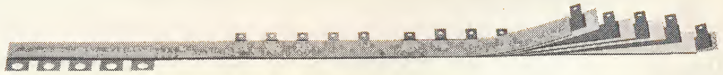
In every electronic assembly power must be distributed, from one point to another. Transistor operating voltages must be provided at many points in the circuit. Until now, these were connected by multi-wire harnesses or by repetitive wiring, which were bulky and time-consuming to install and verify, requiring extra components or tie points, and which contained the possibility of wiring error.

Now in one compact unit, the ELDRE BUS, a multiplicity of voltages can be transferred to any part of the circuit and connected where needed. Wiring time is greatly reduced, harness wiring and repetitive wiring are eliminated, wiring is made easier . . . the benefits are endless.

It is the purpose of this booklet to acquaint the design engineer with the advantages of a bus in power distribution. An important property of a distribution bus is its ability to reduce noise pick-up. Data will also be given to enable the engineer to design or specify a bus for his particular application.

DESCRIPTION OF THE ELDRE BUS

The ELDRE BUS consists of flat conductors, insulated from each other and molded into a completely sealed multi-conductor unit. Each conductor has terminations specified by the customer at points to suit each individual requirement. Any number and type of terminations may be specified. Thus a voltage or voltages can be applied anywhere and everywhere necessary.



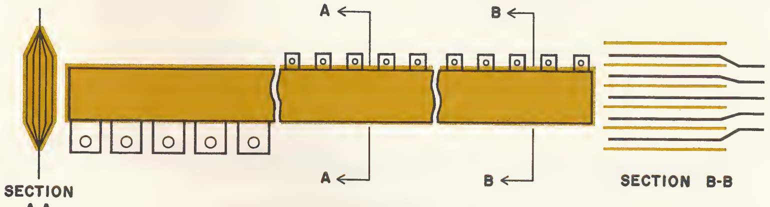
Partly molded bus showing laminated construction.

Each ELDRE BUS is custom made to meet electrical and mechanical requirements. Mounting holes may be incorporated into each bus. Inasmuch as each conductor is stamped out of the metal desired, any type of termination such as solder-type, quick connect, spade or ring lugs, screw-type, etc. can be designed into the bus.

If wire wrap* terminations are required, .032″ or .045″ brass or copper stock is suggested. Thus, when each termination is stamped out, a standard wire terminal, .062″ x .032″ or .045″ x .045″, will be obtained. If desired, the copper conductors may be coated with tin, silver, gold, etc.

*Gardner-Denver Co. Registered Trademark

The number of conductors or levels, the type and number of terminations, material and its thickness and treatment depend upon the application. The bus bar construction is made by assembling alternating conductors and AMRON** insulation successively, and molding the bar completely. All edges are sealed, resulting in a neat, compact assembly, eliminating electrical shorting from outside foreign matter. Insulation overlap should be equal to the overall thickness of the bus. Close mechanical tolerances can be maintained in the finalized unit.



Typical construction of a bus.

DESIGNING THE BUS

High speed solid-state circuits demand greater attenuation of electrical noise. It is important that power distribution circuits be designed and placed with reference to minimum noise pick-up. Many malfunctions in switching circuits can be readily attributable to the presence of electrical noise in the circuit.

In addition, because transistors require relatively high currents and low voltages compared to equivalent circuits using vacuum tubes, it is essential that the DC power distribution lines have greatly reduced resistance and inductance. Inductance which could be tolerated in vacuum tube circuits can cause havoc in solid-state switching circuits. Resistance can be readily reduced by increasing the cross-sectional area of the conductor. However, a relatively large increase in the size of the conductor will have only a slight effect on reducing the inductance.

**Trademark of Eldre Components, Inc.

Large copper conductors are quite effective in reducing the impedance in a power distribution system for vacuum tube circuits with fast rise times. However, they are not sufficient in a similar transistor circuit. Though the actual value of resulting dynamic voltage drop may be small, it is still large in comparison to the low voltages used in transistor circuits. These conductors are also a possible source of noise which could not be tolerated in switching circuits. Again, increasing the thickness of the conductor reduces the resistance but has negligible effect on inductance.

Inasmuch as merely increasing the size of the conductors is not the answer to reducing the inductance and resistance of a line, the solution to the problem must lie elsewhere. Research in the field of data handling has given us a new concept in AC and DC power distribution—THE LAMINATED DISTRIBUTION BUS.

To obtain minimum inductance it is essential that conductors be placed close together to reduce the magnetic field. In this way, the magnetic fields around each conductor which are 180° out of phase with each other, will tend to cancel, reducing the total field and the possible source of noise. It has been the practice to use a twisted pair of wires to achieve this end. However, a twisted pair of #20 wire will have approximately 141 times the inductance of a distribution bus of .005″ thick copper conductors. The superiority of the distribution bus is dramatically obvious.

To be able to manufacture a distribution bus we must know the cross-sectional area of the conductor and the thickness of dielectric desired. Total length and terminations can readily be established from the application.

The cross-sectional area is dictated by the current requirements of the system which the bus will feed. This can be calculated from the following formula, assuming an ambient temperature of 40°C.

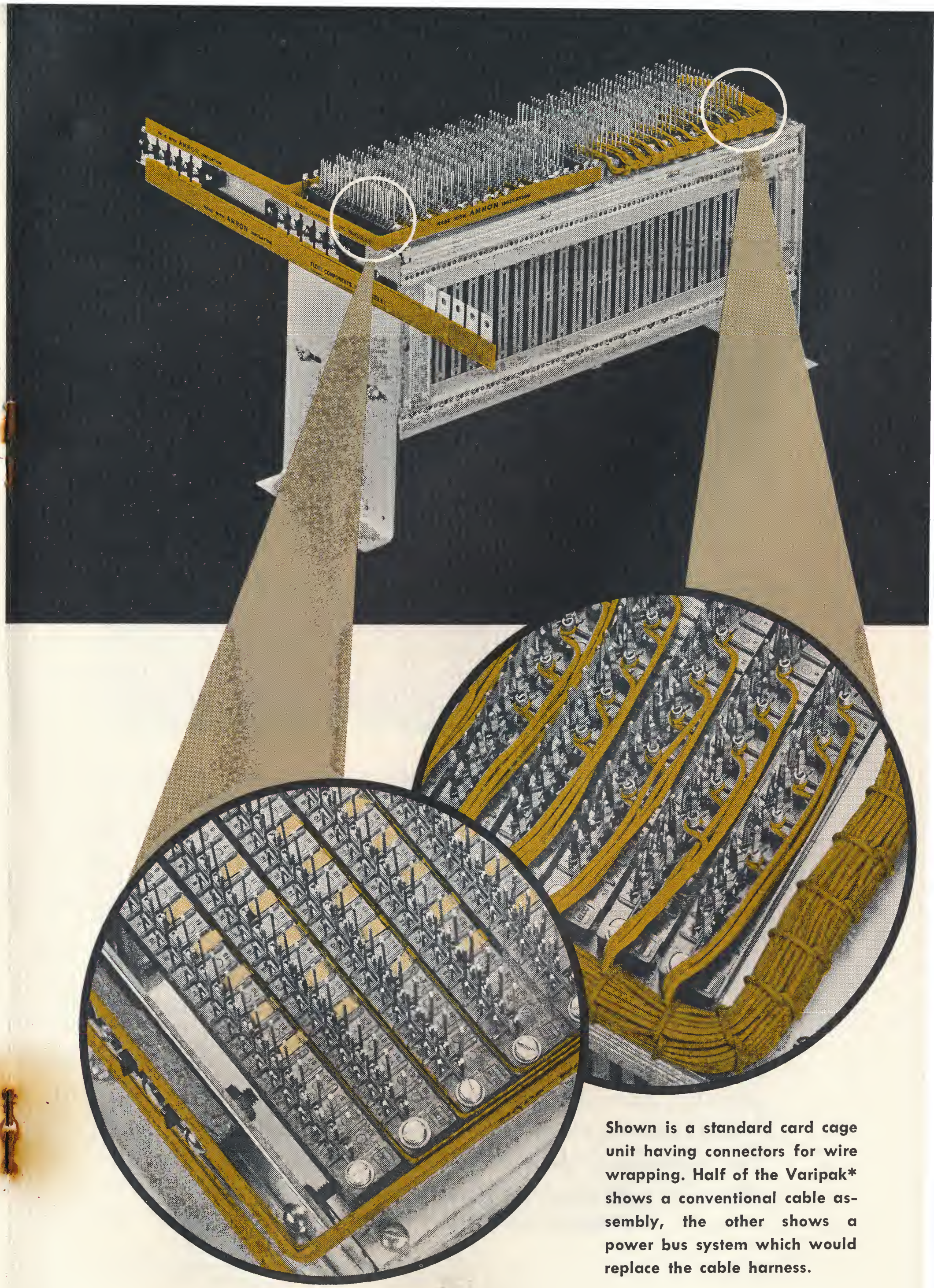
$$A = \frac{1207\,L(I)}{Ecc\,(E)}$$

A = cross-sectional area of copper conductors in circular mils
L = total length of conductor from power source to load and return, in feet
I = peak current flow in amperes
Ecc = DC supply voltage
E = per cent of allowable voltage drop

See bottom of page 8 for converting square mils to circular mils.

This formula also holds true for a twisted pair of wires. But it can be seen that where the conductor length is long and/or the peak current requirement is high, the cross-sectional area of the wires would necessarily have to be unduly large. This is especially true in transistorized circuits where Ecc and allowable per cent of voltage drop is very small. Again we see that for power distribution in high-speed, solid-state circuits and complex control systems, the use of flat copper conductors is dictated. In addition, the distribution bus provides low inductance as well as low resistance for excellent dynamic and steady-state characteristics.

A copper conductor of .010″ thick and .375″ wide is sufficient to conduct 15 amperes at average solid state voltages at 40°C. The inductance of a bus is determined by the width of the copper and the thickness of dielectric between conductors. Thus, when the maximum allowable inductance per foot is known, the ratio of spacing between conductors to width of bus can be calculated. The spacing between conductors or the thickness of dielectric required is of course determined by the voltage level of each adjacent conductor. (See section on AMRON insulation)



Shown is a standard card cage unit having connectors for wire wrapping. Half of the Varipak* shows a conventional cable assembly, the other shows a power bus system which would replace the cable harness.

*Elco Registered Trademark

SYMBOL OF PERFECTION

The inductance of a copper bus can be calculated from the following formula when the length of the bus is long compared to the width, which is normally the case.

$$L = \frac{0.56\,T}{W}$$

L=microhenry per foot
T=thickness of dielectric between conductors, inches
W=width of bus, inches

The closer the conductors in the bus bar, the lower the inductance of a given length. Dynamic currents will tend to flow where the conductors are close together. If wider spacing is used, the dynamic current would concentrate on the surface of the conductors creating a large dynamic voltage drop due to the skin effect and increased inductance. Therefore a bus containing several parallel conductors or circuits would have lower inductance per circuit to dynamic currents than a bus containing only two conductors.

The design of a copper distribution bus can be evaluated in terms of voltage drop at 40°C with the following formula.

$$E = \frac{24{,}140}{A}$$

E=mv/ amp/ foot drop of conductor pairs
A=cross-sectional area of conductors in circular mils, per plate

When the actual length of the copper bus and current are known, the following formula will give the actual voltage drop.

$$E = \frac{24{,}140\,L(I)}{A}$$

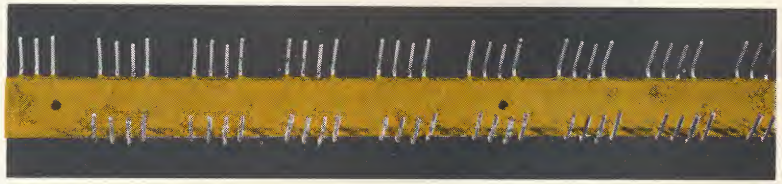
E=millivolt drop
L=total length of conductor pair, foot
I=peak current, amperes
A=cross-sectional area per plate of conductors, in circular mils

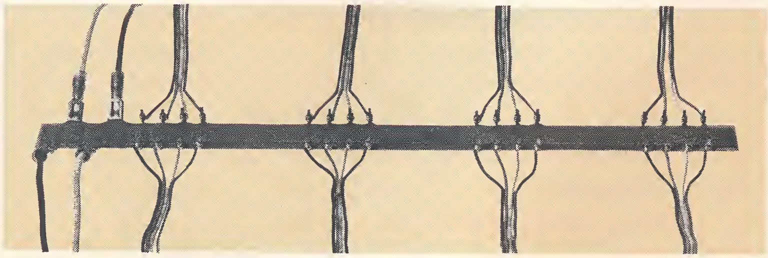
To convert the area of the copper bus to circular mils:

Circular mils of flat bus=1.2732 (width of bus × thickness of bus in mils)

AMRON INSULATION

AMRON insulation, a product of Eldre Components, Inc., is made up of a non-woven dacron® matting bonded to mylar® impregnated with a resin. This composite insulation has very stable characteristics and is available in several material thicknesses. Two of these are given in the table on the following page. With the mylar sealed within the dacron mats an excellent functional class B material results.





Eldre Bus using standard-size wire wrap terminals.

This dacron-mylar combination has a wide range of desirable properties. There are excellent heat aging and thermal stability characteristics. It provides low current leakage characteristics, high physical strength and good chemical resistance. The material can be creased and cuffed without destroying its properties. Dielectric strength is relatively high.

® Dacron—Dupont's trademark for its Polyester Fiber
® Mylar—Dupont's trademark for its Polyester Film

AMRON INSULATION PROPERTIES

AMRON No.	Material	Thickness (approx.)	Tensile Strength Lbs./In. of Width	Finch Edge Tear Lbs./In. of Width	Dielectric Strength
1	.002'' DACRON .001'' MYLAR .002'' DACRON	.005''	48	86	5000 VDC
2	.003'' DACRON .002'' MYLAR .003'' DACRON	.008''	90	190	7500 VDC

RELIABILITY TESTING

Every bus, after being manufactured to specifications, receives a "high-pot" test which assures no electrical defects exist in the assembly. Each conductor or level is tested to be sure that it meets all mechanical requirements. An environmental chamber is used to verify various degrees of humidity under which a bus can be expected to operate. This assures the reliability of a bus under such conditions.

PRICING OF BUSES

Prices of buses vary with quantities ordered, the difficulty of fabrication, types and numbers of terminations, kind and treatment of metal conductor, size, etc. Certainly the cost is no more than that of manufacturing, installing and verifying the ordinary cable and wire circuits. The many advantages of an ELDRE BUS make it superior to customary wiring procedures.

SUMMARY

The ELDRE BUS is finding wide application in the circuits of data processing and complex control systems. The advantages of the bus include extremely low inductance and resistance while placing the distribution lines in a compact and neat assembly. Cable harnesses and repetitive wiring are eliminated. Wiring errors are minimized. The bus is easy to install and is low in cost. Impedance and capacitance can be maintained more exactly than conventional wiring techniques. The control of unwanted electrical noise and disturbances is a highly important property.

In this booklet, data has been given for designing a bus to fit your application. ELDRE can manufacture a bus to your electrical and mechanical specifications while satisfying the most demanding requirements. Constant quality control assures each bus will meet or exceed specifications.

If you think there is a place for a bus in your circuitry, or would just like to talk over the possibility, call or write ELDRE COMPONENTS, INC., ROCHESTER, N. Y. and we will be pleased to discuss this with you.

ELDRE COMPONENTS, INC. • 1239 UNIVERSITY AVENUE • ROCHESTER, N. Y. 14607
AREA CODE 716 - CH 4-2570

Area Code 716
CH 4-2570

ELDRE COMPONENTS, INC.

1239 UNIVERSITY AVE. • ROCHESTER, N. Y. 14607

January 6, 1965

Mr. T. Nelson
Sys. Consultant
Box 1546
Poughkeepsie, New York 12603

Dear Mr. Nelson:

In answer to your request for information on our laminated and molded bus bars, we are enclosing our Technical Bulletin and a sample of our bus.

We have made numerous types of these low inductive power or signal distribution buses, and we have many off-the-shelf buses available. Thus we have compiled considerable data in this specialty. If you require additional information, we would be pleased to offer our assistance.

Thank you for considering our products and we hope to be of service to you.

Very truly yours,

ELDRE COMPONENTS, INC.

Jerome A. Kliman

Jerome A. Kliman
Market Director

JAK/mu
Encl.

Gentlemen:

☐ *We use cable harnesses in our product*

☐ *We are interested in technical information only*

☐ *We are interested in design assistance*

☐ *Please have Sales Engineer call*

☐ *Place my name on mailing list*

NAME ______________________ TITLE ______________

FIRM NAME ______________________________________

ADDRESS ____

CITY ______________ STATE ______________ PHONE No. ______________

FIRST CLASS
PERMIT NO. 3585
ROCHESTER,
NEW YORK

BUSINESS REPLY MAIL

NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

POSTAGE WILL BE PAID BY —

ELDRE COMPONENTS, INC.

1239 UNIVERSITY AVE.

ROCHESTER, NEW YORK 14607


ELDRE COMPONENTS, INC. ROCHESTER, N. Y.


MADE WITH AMRON INSULATION